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THE COMPARATIVE EFFICIENCY OF FOUR TYPES OF ENDODONTIC FILES AN--ETC(U)
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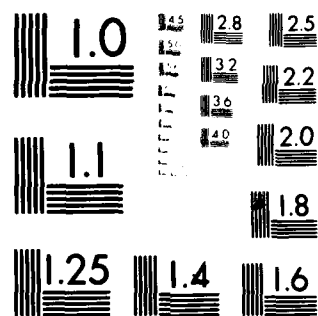
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The Comparative Efficiency of Four Types
of Endodontic Files and Reamers

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ABSTRACT

Eighty artificial root canals were created in individual sections of bovine bone. Each canal was instrumented to a size 80 using four types of endodontic instruments: Hedstrom files; K-files; reamers; and the new Unifile. Using volume of bone removed per unit of time, the efficiency of instruments was compared. The Hedstrom file proved statistically ($p < .05$) to be the most efficient in removing bone from the straight artificial canals.

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Craig and Peyton¹ showed that endodontic instrument's cutting efficiencies are not constant, but may vary due to manufacturer, and age or type of instrument. Today the main types of endodontic instruments in use are the K-file, reamer, and Hedström file. Recently, the Burns' Unifile has been marketed which claims to have the combined advantages of the other instruments.²

In the past, extracted teeth were generally used to evaluate instrument efficiency,³⁻⁵ although Walton⁶ did evaluate teeth instrumented prior to extraction. This evaluation was often made by histologically evaluating the appearance of the instrumented canals.^{3,5,6} Several problems arise in using extracted teeth for comparison of instruments. Most serious is the inability to begin instrumentation from exactly the same point since each canal has an individual morphology.⁷ Also, it is possible for the dentin of teeth from many different people to vary extensively in hardness.⁸

To avoid the problem of different size and shape of canals, Molven⁹ used dentin wafers as cutting samples with the size of the prepared openings being measured pre- and postoperatively. Unfortunately, he tested the cutting efficiency of only one size instrument of each of several different types of instruments. It can be questioned if cutting efficiency can be well measured by testing instruments individually. Clinical efficiency appears to relate more to the ability of a group of instruments to produce a final tapering canal in a minimum amount of time. To satisfy these requirements of identical size canals and identical material hardness, and in order to evaluate complete serial

instrumentation, Weine⁷ used acrylic blocks with artificial canals. Unfortunately, how well acrylic relates to tooth structure has been questioned.¹⁰

Lugassy¹¹ has shown that due to the orientation of its structure, bovine bone relates well to dentin as an experimental model. The availability of multiple samples from one location allows the various experimental instruments to be used on nearly identical samples. This avoids the problem of the varying hardness of teeth from multiple sources. Oliet and Sorin,¹² and Webber, Moser and Heuer¹⁰ used the bovine bone to simulate dentin during instrumentation. Oliet and Sorin¹² used a drill press to simulate the action of reamers while Webber, Moser and Heuer¹⁰ used an electric saw to simulate a linear filing action. It can be questioned if either method truly represents the way the instruments are used clinically. In addition, Webber, Moser and Heuer¹⁰ evaluated the cutting efficiency of only size 30 and 50 reamers, files and Hedströms¹⁴ in successive trails. Oliet and Sorin¹¹ did use size 20, 30, 40, and 50 reamers and files, but each instrument was tested individually against dry bone not sequentially in wet canals. Villalobos and others¹³ did use wet bone using rotation, but again only evaluated size 50 and 70 reamers and K-files.

The objective of this study was to compare the instrumentation efficiency of the Burns' Unifile with K-files, Hedström¹⁴ files, and reamers used serially in identical bovine bone canals; the procedures being performed in a clinical manner.

METHODS AND MATERIALS

The experiment utilized eighty sections of moist cortical bone cut from a bovine femur. Each section was cut 5 x 8 x 25mm with a carbide disc metallurgical saw (Buehler Ltd., Evanston, Ill.) using water spray. In each segment, a standardized canal was drilled 17mm deep with a .018 inch metal drill in a micro drill press (Microinstrument Corp., Cambridge, Mass.). Care was taken to use a copious lubricant of mineral oil and low RPM (3500) to avoid burning the bone. Test drilling using this method showed that burning of the bone did not occur. Each segment was next weighed on an analytical balance. Due to the inaccuracy of weighing moist bone in air, the bone was weighed by suspending it in a stationary beaker of water.¹⁴

The eighty sections, stored in distilled water, were divided into four groups of twenty. Each group was instrumented with a different style endodontic instrument: Group 1 - K-files; Group 2 - Hedström files; Group 3 - reamers; Group 4 - Unifiles.

Two operators then instrumented ten of each group with each type of instrument. During instrumentation, each segment was held in a dentoform in the same position (lower right premolar-molar area) using moist 2 x 2 gauzes. The dentoform was mounted in a fixed position which would conform to a clinical situation. To negate operator fatigue, only five canals were instrumented at a time. Prior to instrumentation, five new sets of instruments, sizes 10 to 80, were readied for use with silicone stops set at 18mm, and five 3cc syringes were filled with sterile water. Before using the first instrument, the canal was filled with sterile water. After the use of each instrument, the canal was flushed with 1cc

of the sterile water and the canal left full of water. Primarily, instrumentation was accomplished with a filing action as suggested by Weine and others.⁷ A reaming action was used when the operator felt it appropriate for establishing length, or removing debris. After final instrumentation, the canal was irrigated with the remaining full 3cc syringe of water. Using a stopwatch, each instrumentation was timed from the beginning until the operator was satisfied that the canal was prepared for obturation with a size 80 gutta percha filling. At this time, the segment was stored in distilled water for two days prior to reweighing it, again under water. The difference of pre and post instrumentation weights gave a volumetric loss of bone.¹⁴

The measure of weight loss per unit time was used to compare the efficiency of each of the different instruments within the individual operator's clinical technique. The data was analyzed by two-way analysis of variance with the four treatments on one level and the two operators on the second. Separate analysis was carried out for weight loss and weight loss per unit time.

RESULTS

Figure 1 gives the mean weight loss for each instrument for each operator and their standard deviations. Figure 2 gives the mean time and standard deviation for each instrument for each operator. Figure 3 gives the mean weight loss per second for each instrument for each operator and the standard deviations. The Hedström file in both operator's hands proved to be the most efficient in bone removal per unit time. This was followed by the reamer and Unifile. The K-file was

least efficient for both operators. A two-way analysis of variance was performed to compare the instruments and operators as to weight loss and weight loss (mg) per second. The first comparison showed a significant difference between instruments ($p < .0001$) and between operators ($p < .0001$), but there was no interaction. That is, each operator did use each instrument with the same relative ability when compared to his use of other instruments. The second comparison (weight loss per second) shows a significant difference between instruments and operators indicating that one operator was more efficient in instrumentation. A Sheffé's post hoc comparison was performed to show which instruments were significantly different. The Hedström file was significantly ($p < .05$) more efficient in both operators' hands. No statistically significant difference was achieved amongst the other instruments.

DISCUSSION

The intention of this study was to evaluate the efficiency of the Burns' Unifile in a clinically related manner. Cutting efficiency was defined as the ability of a group of endodontic instruments to produce a final tapered canal in a minimum amount of time. To compare one type of instrument to another, root canals of equal size were created to allow an equal starting point for each instrument.

The object of instrumentation was to prepare the canal for hypothetical obturation with a size 80 gutta-percha point. Therefore, the final taper was basically an arbitrary determination of each operator in using each individual instrument. Still, this variable was controlled by measuring weight loss per unit of time for each

instrument and correlating the resultant data.

The consistency of the amount of bone removed by each operator with each file was startling (Fig 1). The average specimen weighed 6.590 mg while the average experimental bone removal only ranged from 20 to 37 mg or about .5% of the total weight. Still, the standard deviations, in respect to this weight loss and efficiency, were small and consistent with coefficients of variation that averaged 0.12 (range 0.09-0.16) for weight loss and 0.15 (range .09-.22) for efficiency. This consistency of results certainly gives credence to both the accuracy of the measuring method and the consistency of operator performance.

The results did show that the relative efficiency of each instrument was almost identical for each operator, but that the efficiency of the individual operators was different. Figures 1 and 2 graphically illustrate this relation between operators and instruments. They do indicate that, while the individual operator's experience and style of instrumentation did vary, the instruments still performed in the same manner.

The results showed the Hedström file to be the most efficient of the group by removing more bone in the least amount of time. The Unifile was found to be slightly more efficient than the K-file, but this was not statistically significant.

To see if the operator's non-familiarity when first using a new instrument in the model system was significant, the data was recalculated after eliminating the first two instruments in each group. The new

set of data was analyzed in the same manner as the original sample. The difference was surprisingly small and not at all significant statistically.

Somewhat surprising was a finding by both operators that the larger size Unifiles did not go easily to the working length, and also showed a surprising lack of flexibility. It appears more study is indicated to evaluate its performance in small curved canals. Conversely, this apparent sturdiness of the Unifile may be an advantage in preventing instrument breakage. In this study, none of the instruments fractured.

Comparison of the findings here to the findings of previous studies is somewhat difficult since none of the previous studies evaluated the efficiency of a series of individual types of instruments to remove canal material per unit of time. Some studies did use the instruments in series,⁴⁻⁷ but they usually evaluated the final shape of the canal produced, not the efficiency of the instruments being used. Other studies basically evaluated the use of individual instruments in only one motion, rotational or linear.^{10,12,13} Still, most of the findings presented here were not that different from these previous studies. In fact, the finding here that the reamer was as efficient per unit of time as the file correlated well with findings of Webber and others.¹⁰ However, there was one major area of disagreement. The finding of the increased efficiency of the Hedström file. While this agreed with many peoples clinical impression, it didn't correlate well with Webber and others,¹⁰ or Villalobos and others.¹³ It is proposed that the reason for the difference is that forces placed mechanically on the Hedström,

as done by both studies, did not relate well to how the forces are actually placed on the Hedström clinically.

In conclusion, bovine bone did appear to be an excellent model system. All the sections came from one animal, and all the instrumentation started in created canals of basically identical size.

SUMMARY AND CONCLUSION

Eighty bovine bone model artificial root canals were instrumented using four types of endodontic instruments. Their efficiency was evaluated by the amount of bone each removed per unit of time.

Hedström files were significantly more efficient than the K-files, reamers, or the Unifile when used in a clinical manner in straight canals. The efficiency of K-files, reamers and Unifiles were not significantly different.

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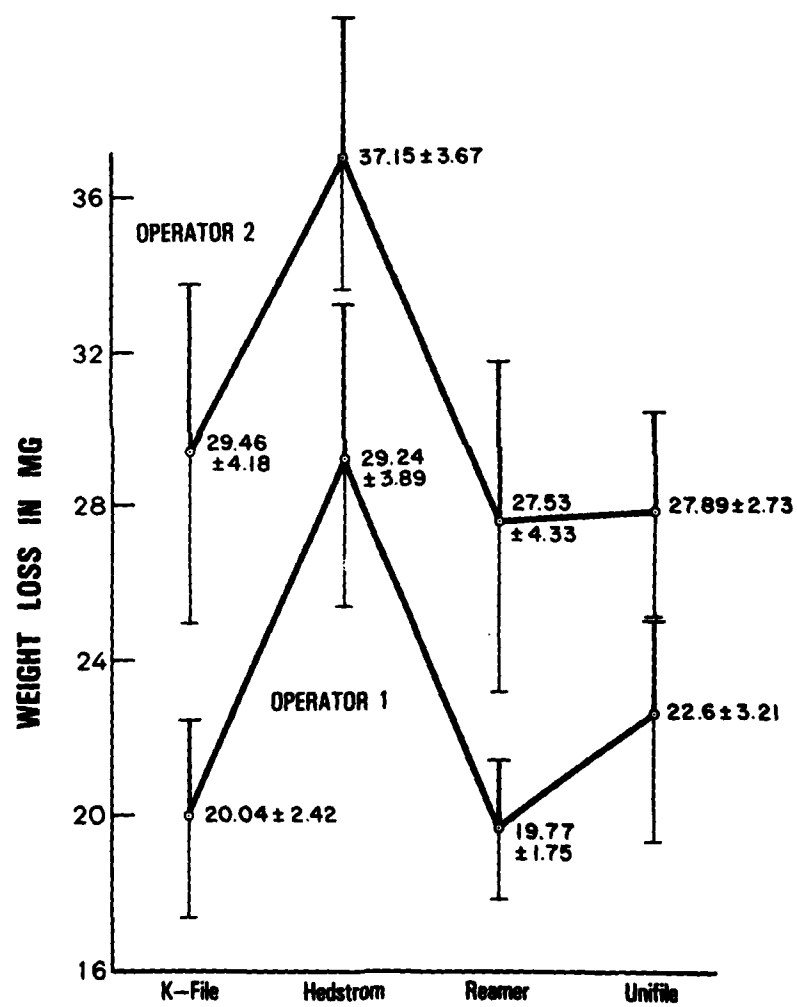
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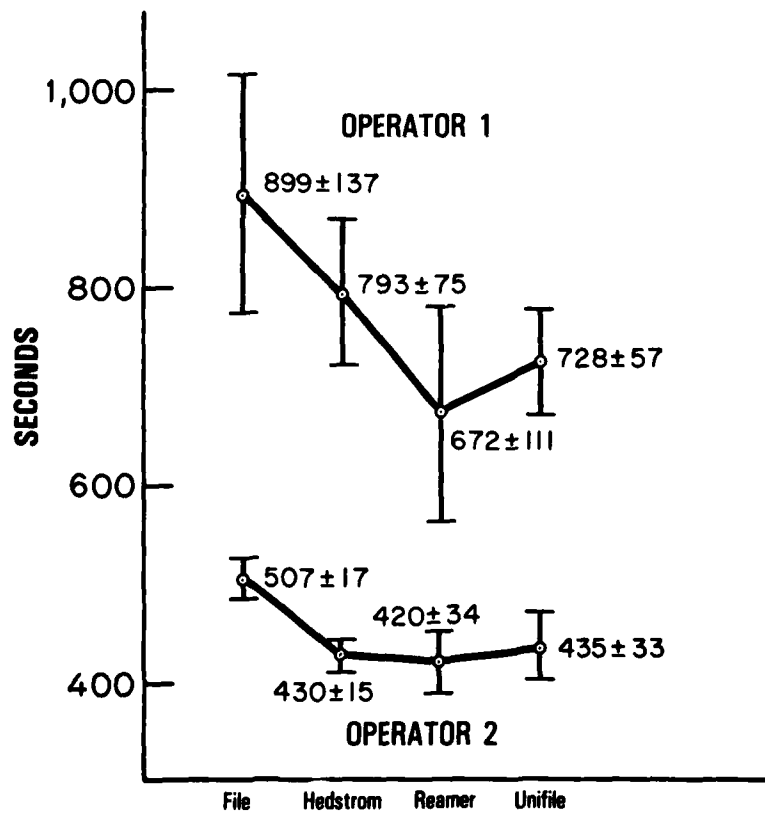
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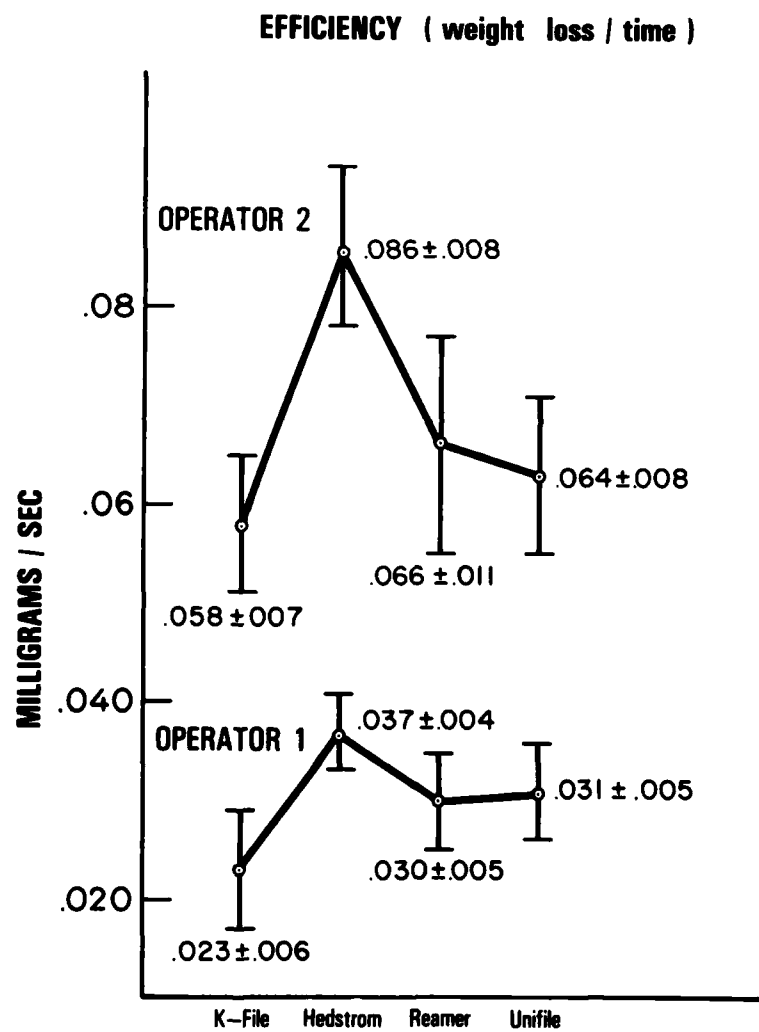
WEIGHT LOSS BY TYPE OF INSTRUMENT



TIME IN SECONDS

Mean \pm s.d.





- Figure 1 Weight loss for each operator (\pm s.d.) for each type of instruments.
- Figure 2 Operating time in seconds for each operator (\pm s.d.) for each type of instrument.
- Figure 3 Efficiency or weight loss per unit of time for each operator (\pm s.d.) for each type of instrument.

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